



Vortrag zum Kollaborationstreffen DELTA-COSY-GSI

BPM System am SIS18

Kevin Lang,

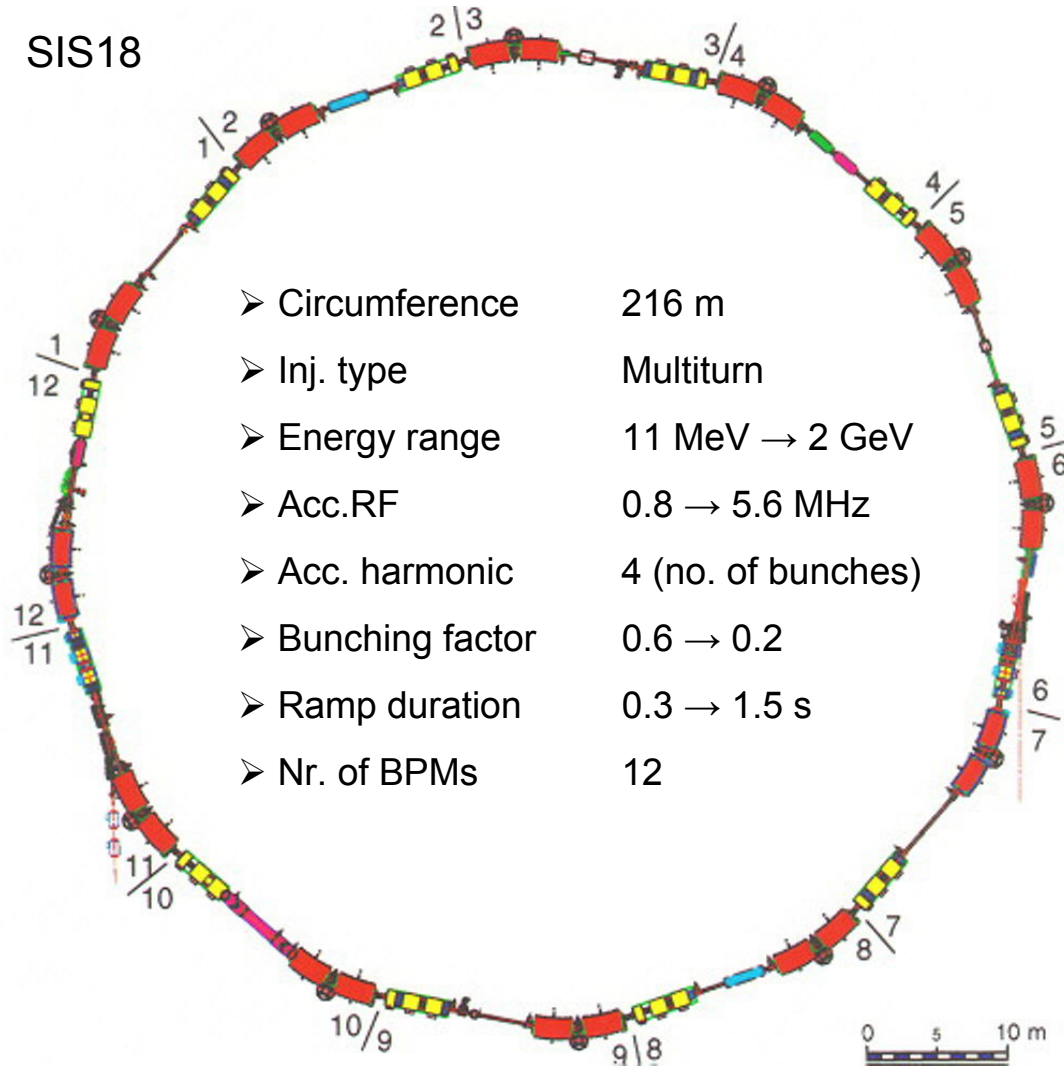
GSI - Strahldiagnose

Outline

- BPMs at SIS18
- Position Measurement
 - Calculation Algorithm
 - Baseline Restoration
 - Timestamps
- Interfaces for Position Data
 - GSI BPM Core
 - Dataflow and Controlling inside Libera
 - Gigabit Ethernet
- Position Data Acquisition
 - Infrastructure
 - GUI

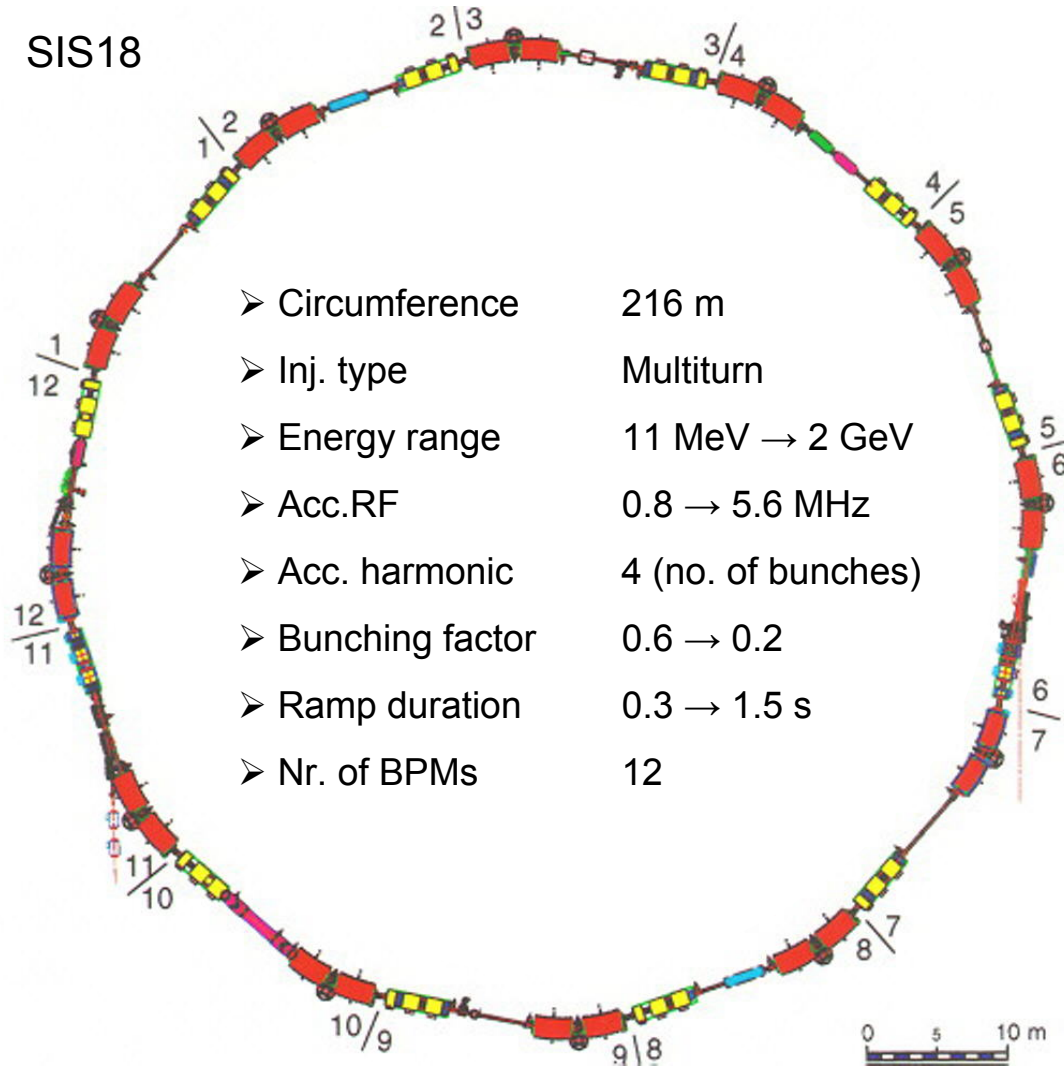
BPMs at SIS 18

SIS18

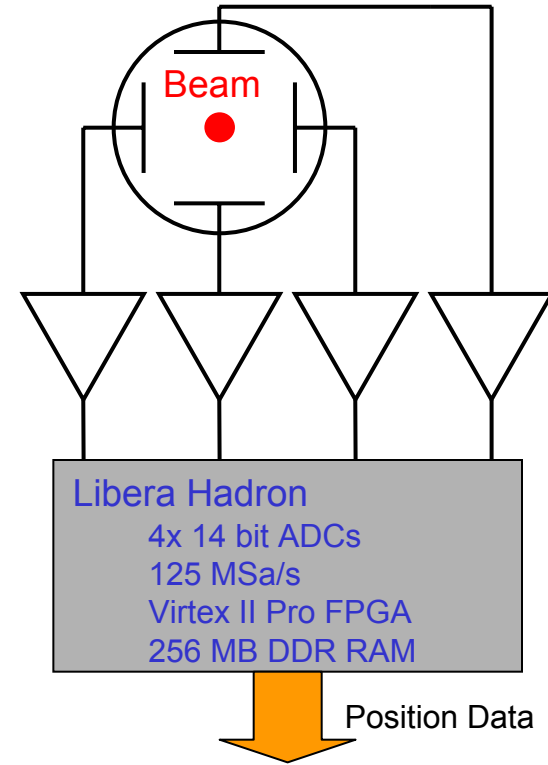


BPMs at SIS 18

SIS18



- Circumference 216 m
- Inj. type Multiturn
- Energy range 11 MeV → 2 GeV
- Acc. RF 0.8 → 5.6 MHz
- Acc. harmonic 4 (no. of bunches)
- Bunching factor 0.6 → 0.2
- Ramp duration 0.3 → 1.5 s
- Nr. of BPMs 12



Position data for each bunch at each BPM. Allows measurement of:

- Bunch by Bunch
- Closed Orbit
- Turn by Turn
- Tune

Position Calculation

$$s = K \cdot \frac{\int \Delta}{\int \Sigma} + K_o$$

K: Pick-Up coefficient:

horizontal: 171 mm to 174.1 mm

vertical: 50.3 mm to 51.5 mm

K_o: Pick-Up offset

horizontal: -0.53 mm to 1.64 mm

vertical: -0.23 to 0.18 (vertical)

Position Calculation

$$s = K \cdot \frac{\int \Delta}{\int \Sigma} + K_0$$

K: Pick-Up coefficient:

horizontal: 171 mm to 174.1 mm

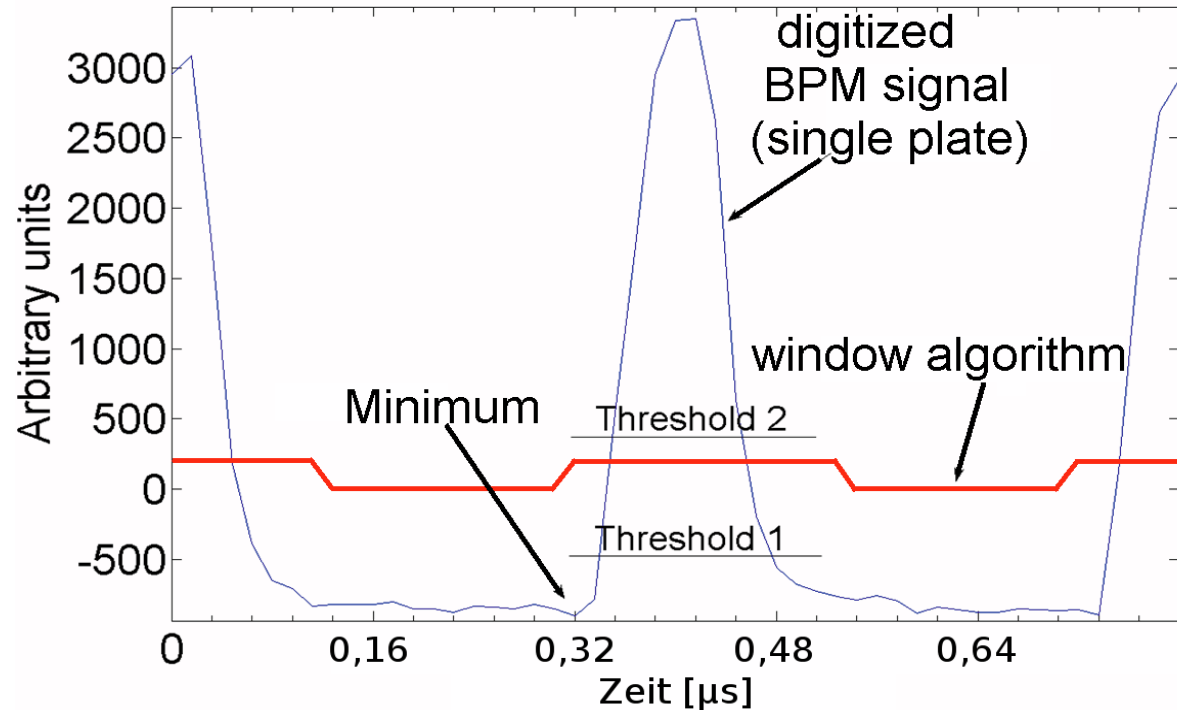
vertical: 50.3 mm to 51.5 mm

K₀: Pick-Up offset

horizontal: -0.53 mm to 1.64 mm

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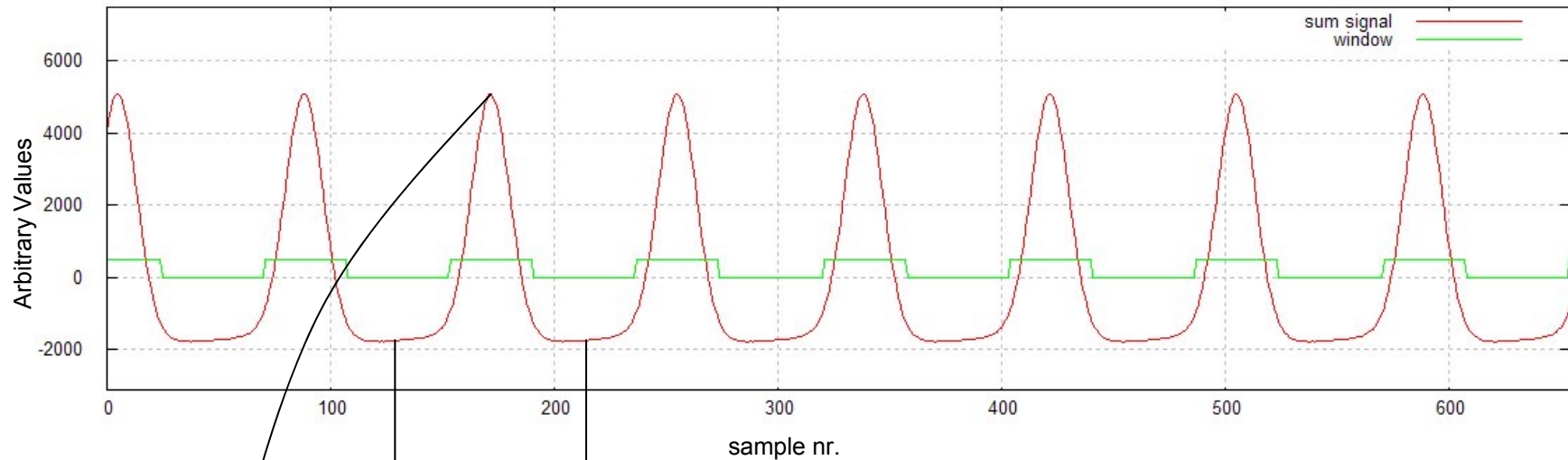
Window management



Integration is only done over the bunch. Therefore an integration window must be generated.

Baseline Restoration

Generated Gaussian Signal (1.5MHz period)



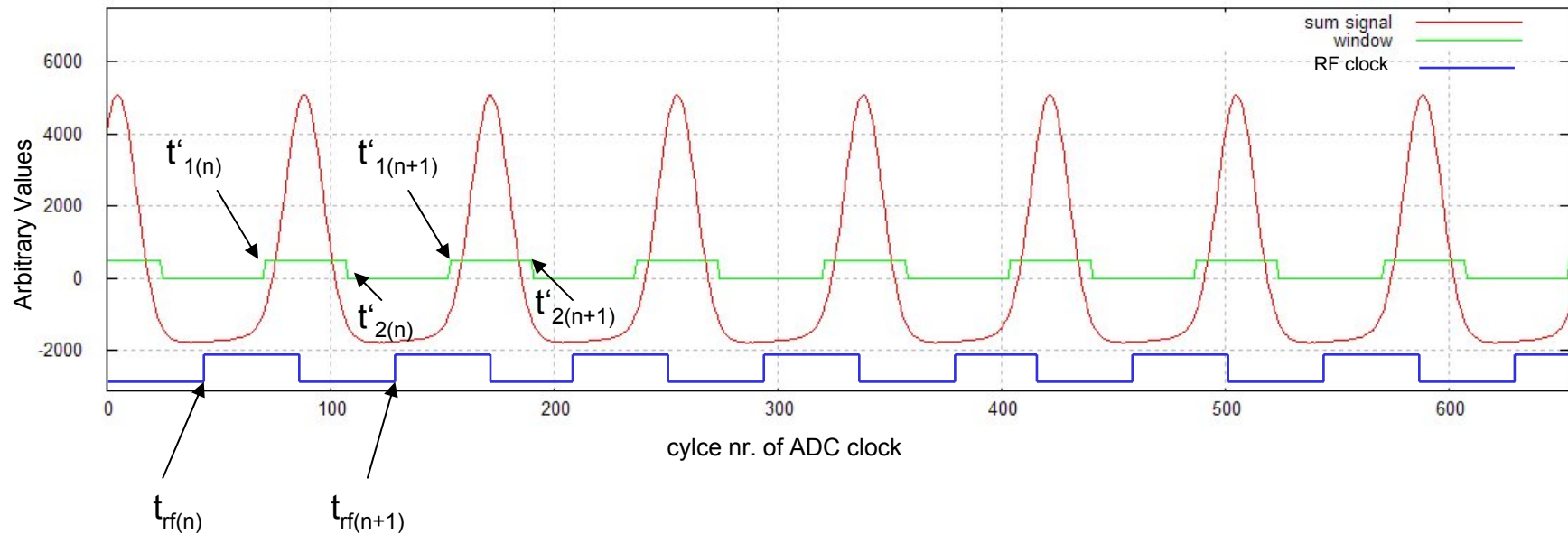
$$y = x_t - \frac{(x_{(t-T/2)} + x_{(t+T/2)})}{2}$$

Max. period of T: 1.25 μ s (0.8KHz)

=> T/2 = 625ns = 79 samples

- Constant delay of 127 is used.
- Results in a latency of $\approx 1 \mu$ s for integral of a bunch.
- Delay can be reduced to 79 cycles (632ns latency).

Timestamps



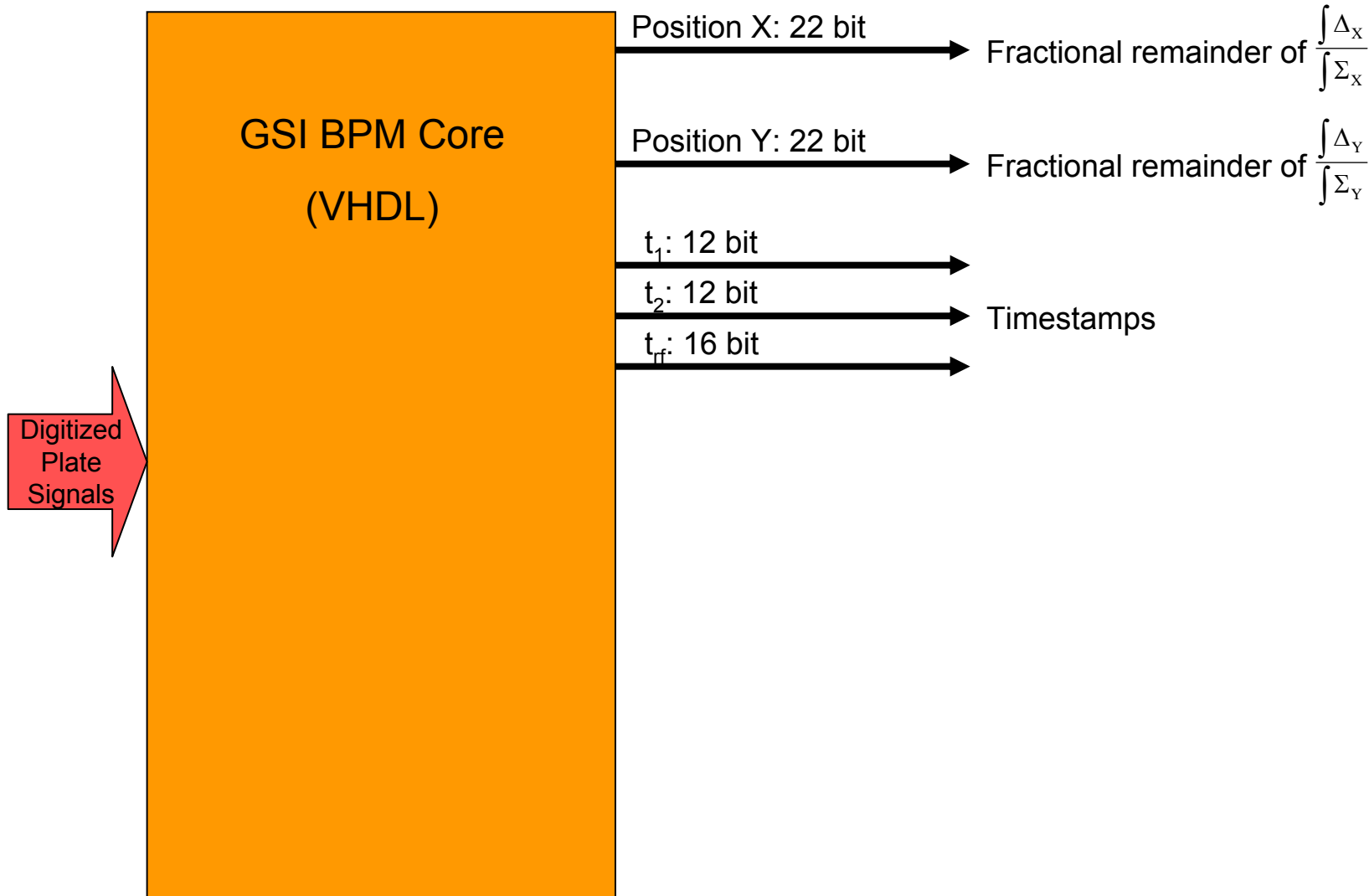
For error detection, measurement of bunch frequency and reconstruction of integration window length, three timestamps are used.

$t_{rf(n)}$ 16 bit absolute value

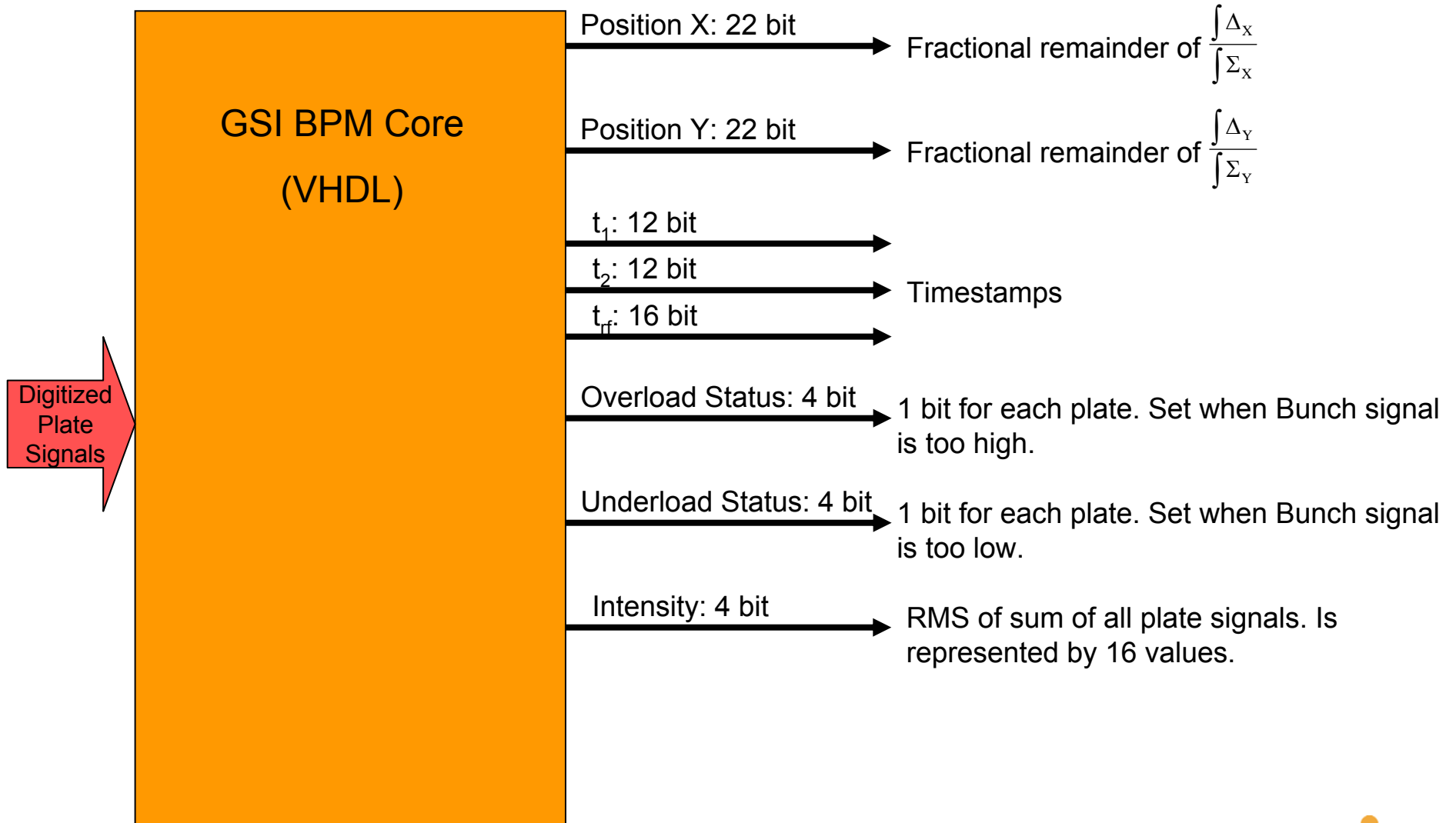
$$t_{1(n)} = t'_{1(n)} - t_{rf(n)} \quad 12 \text{ bit values.}$$

$$t_{2(n)} = t'_{2(n)} - t_{rf(n)}$$

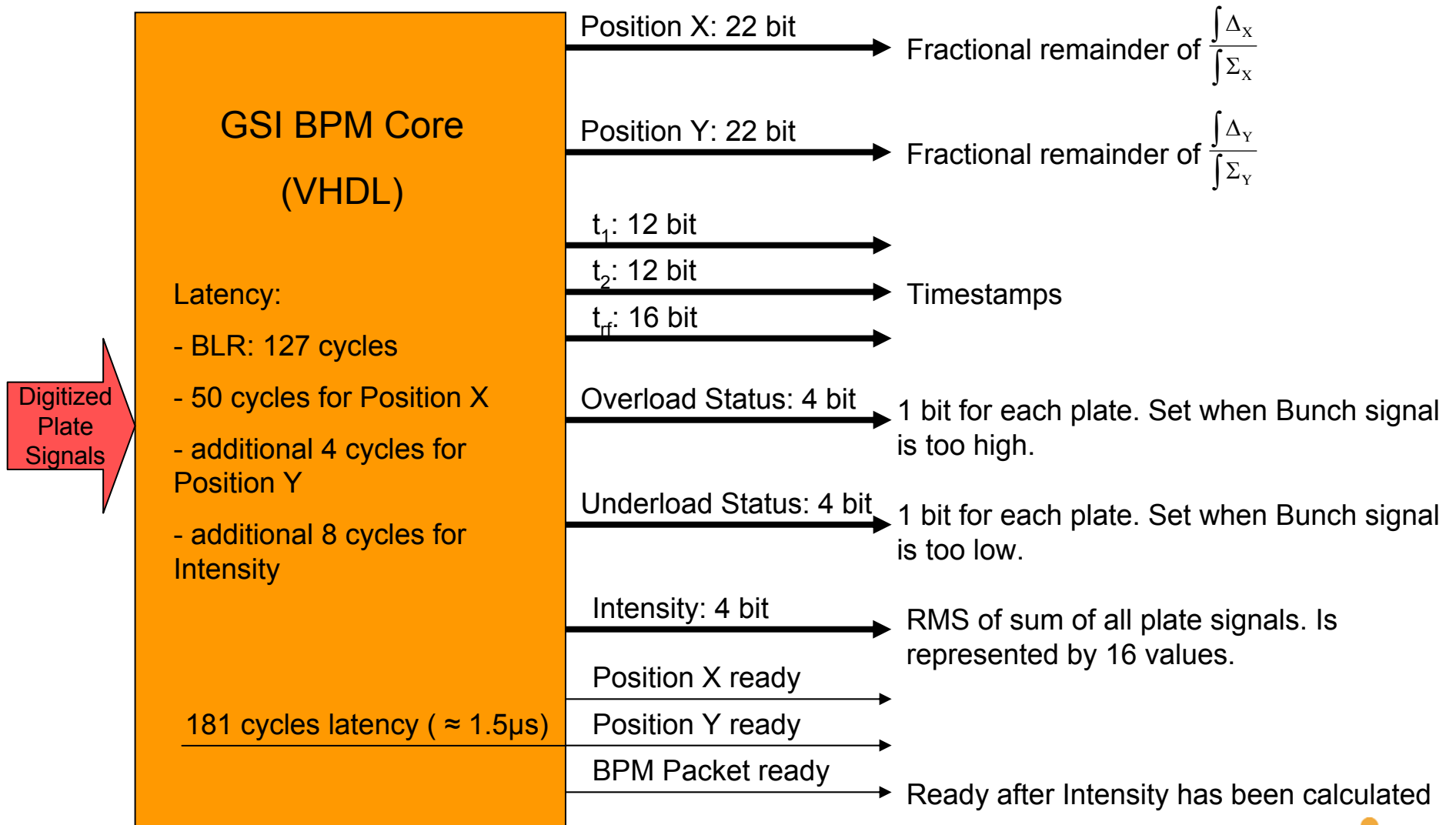
Interface of GSI BPM Core



Interface of GSI BPM Core

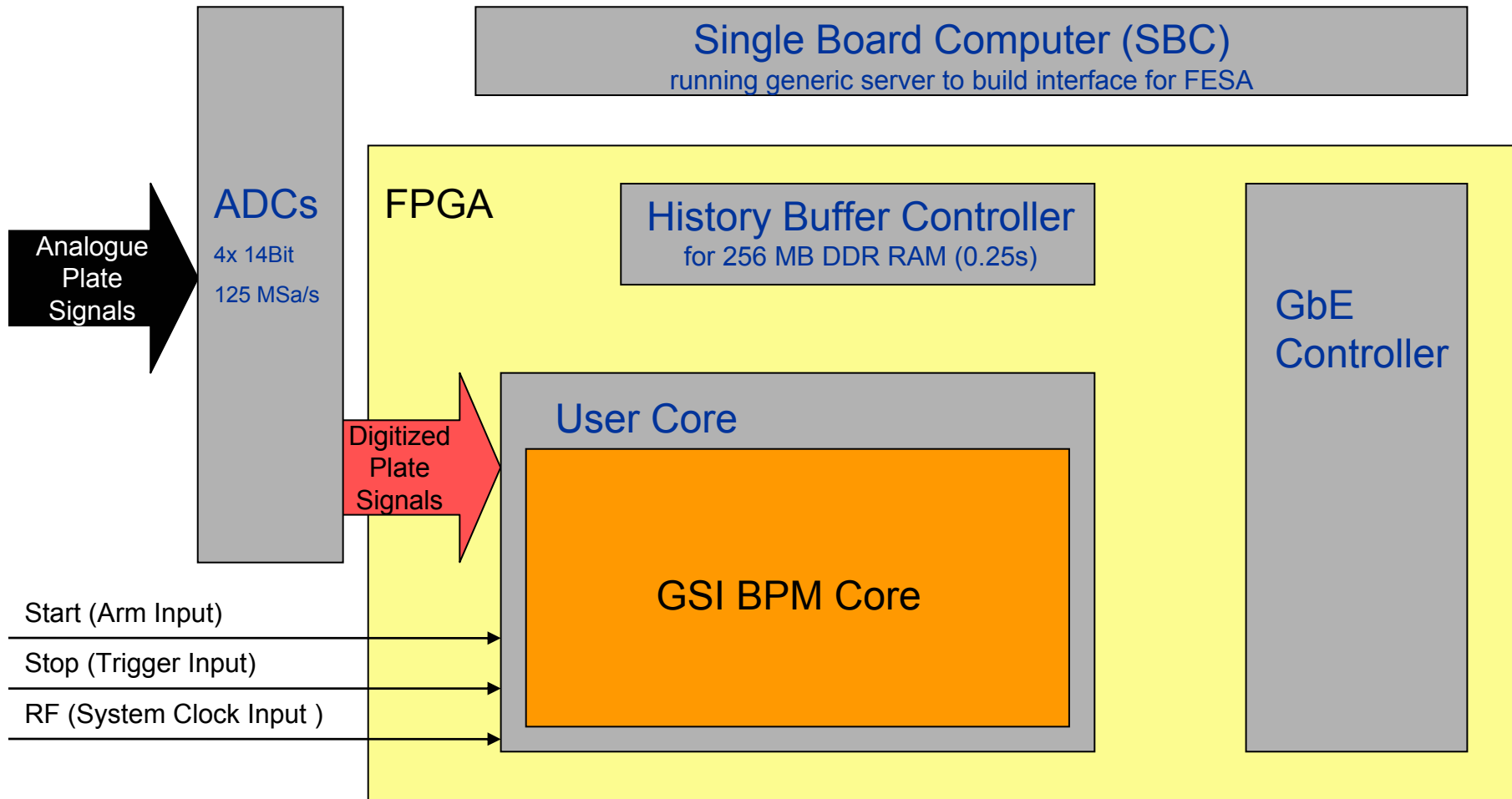


Interface of GSI BPM Core



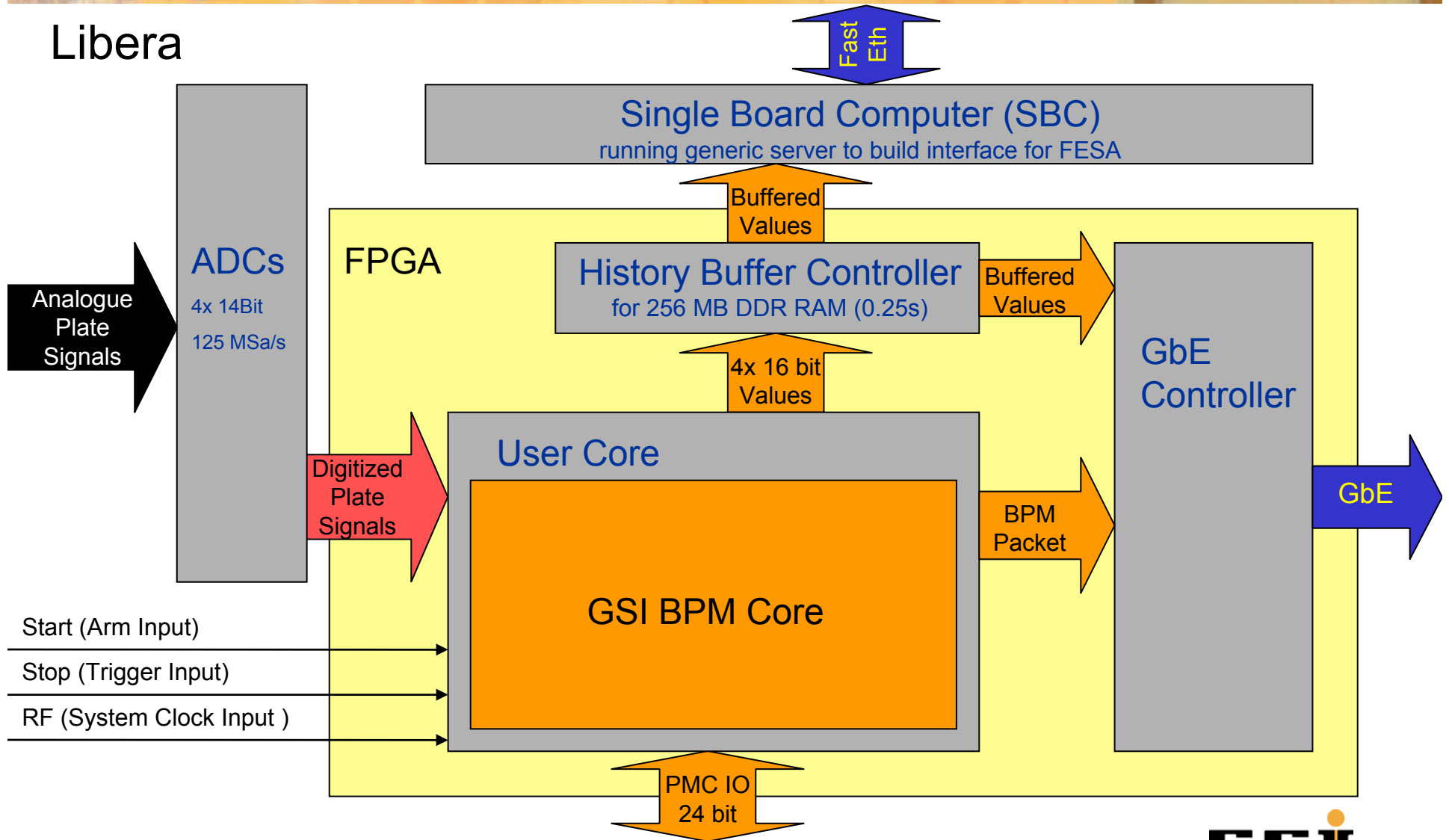
Dataflow and Controlling inside Libera

Libera



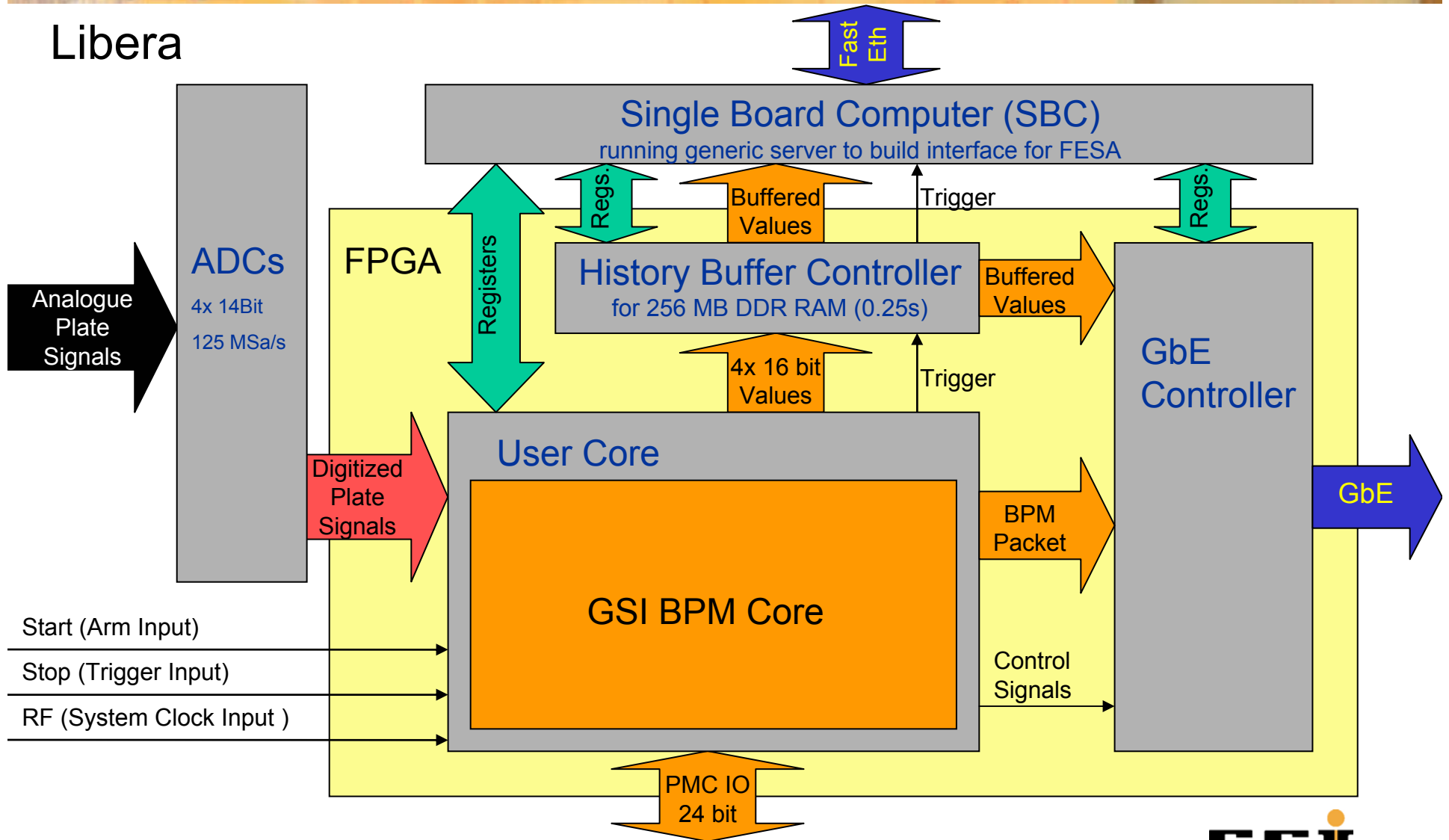
Dataflow and Controlling inside Libera

Libera



Dataflow and Controlling inside Libera

Libera



Gigabit Ethernet Interface

BPM Packet

Position X	Overload Status	Position Y	Underload Status	t_1	t_2	t_{rf}	Intensity
22 bit	4 bit	22 bit	4 bit	12 bit	12 bit	16 bit	4 bit

Gigabit Ethernet Interface

BPM Packet

Position X	Overload Status	Position Y	Underload Status	t_1	t_2	t_{rf}	Intensity
22 bit	4 bit	22 bit	4 bit	12 bit	12 bit	16 bit	4 bit

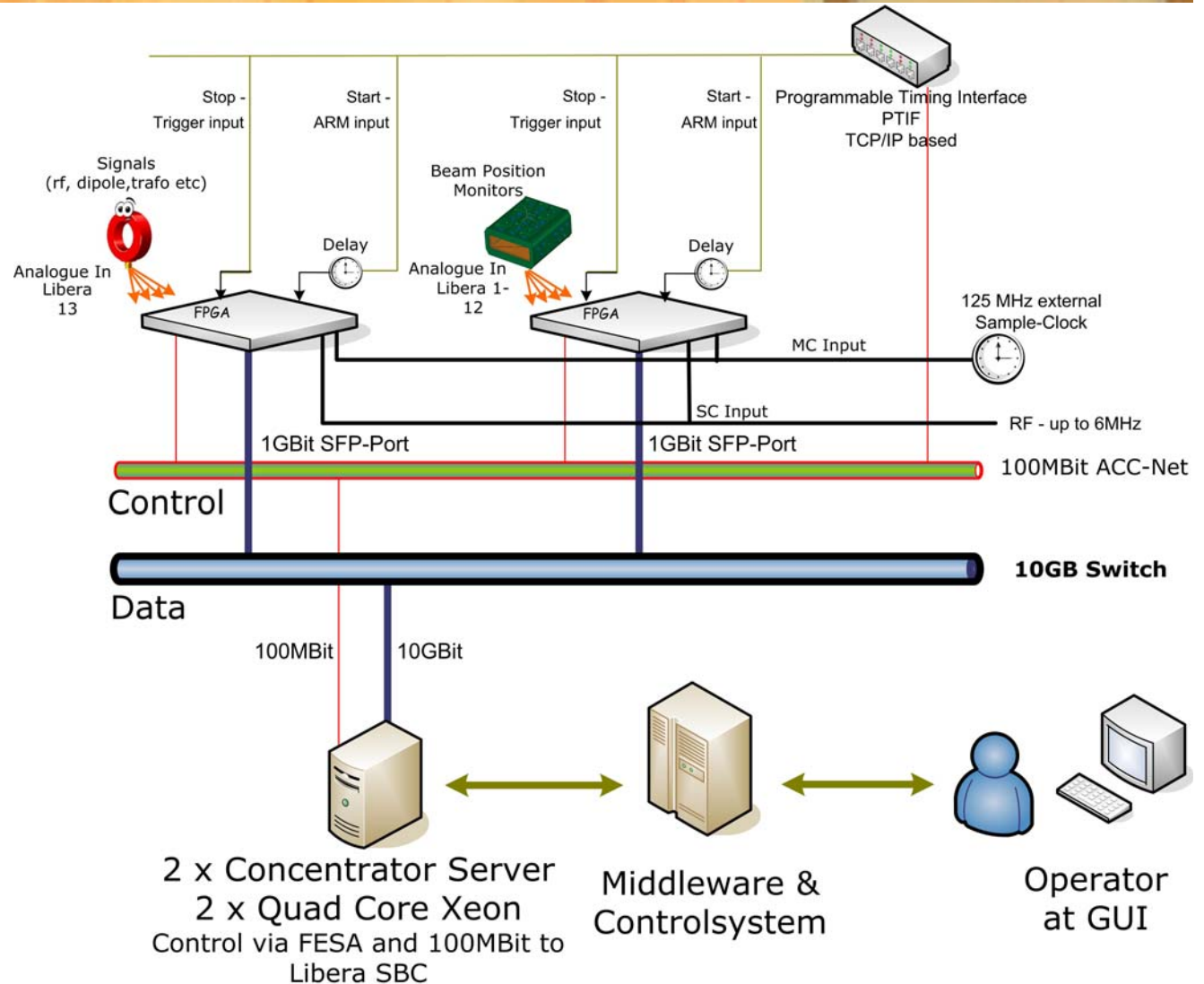
BPM Frame (8192 bytes)

Header(s) ETH/IP/UDP	Size	Frame Type	Cycle Counter	Frame Counter	BPM Packet #0	BPM Packet #1	BPM Packet #677	CRC
42 bytes	2 bytes	2 bytes	2 bytes	4 bytes	12 bytes	12 bytes	678 * 12 bytes = 8136 bytes			4 bytes	

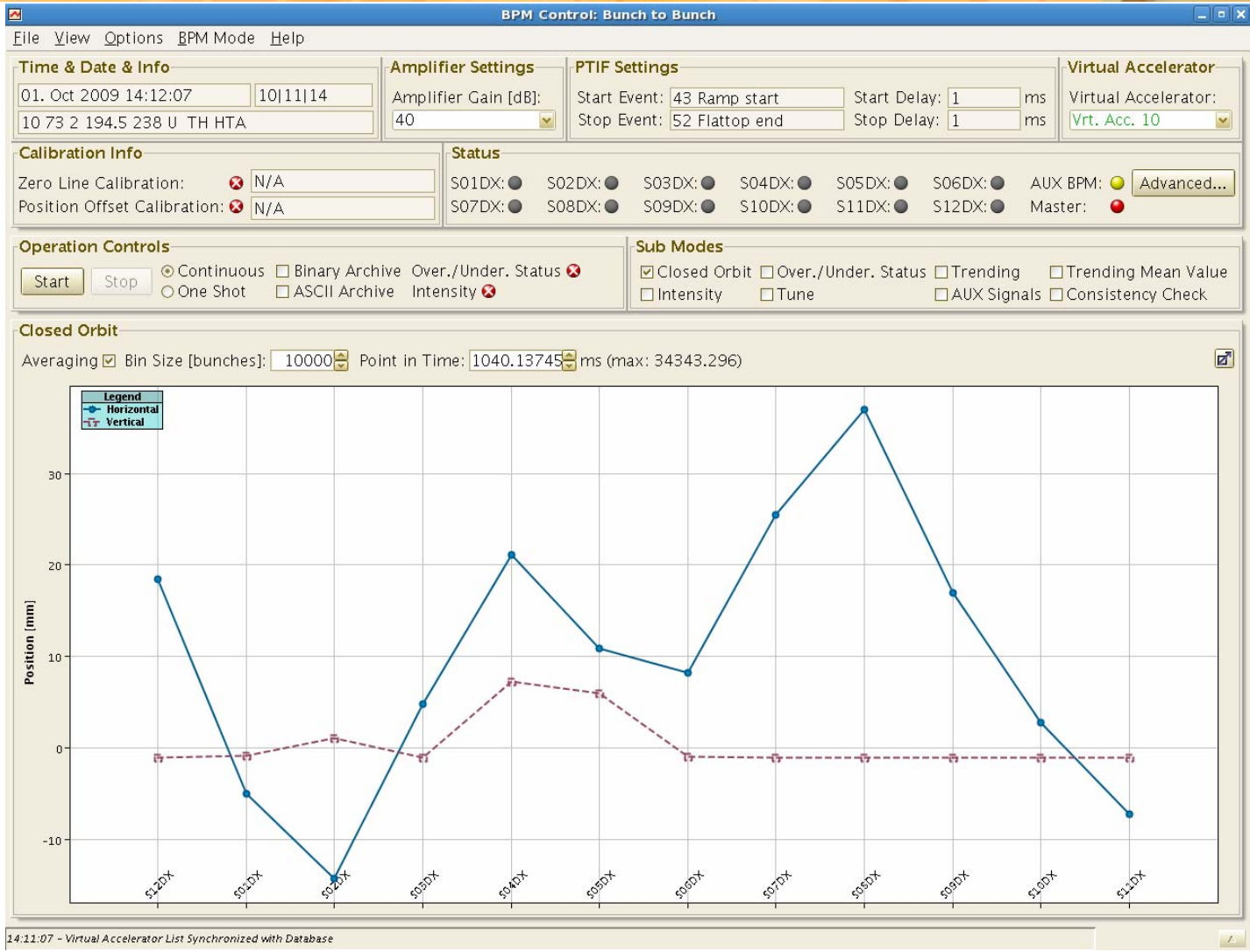
- UDP used as Transport Protocol
- Maximum latency of position data: 0.9ms (@0.8MHz acc. frequency)

Infrastructure for Data Acquisition

- Max. data output of ≈ 68 MB/s per Libera via Gbit Ethernet (5.6 MHz acc. freq.)
- 6 Liberass per Concentrator Server.
- Max. data input of ≈ 400 MB/s per Concentrator Server via 10 Gbit Ethernet.
- Concentrator Server corrects differences of amplifiers (calibration) and uses Pick-Up coefficients and offsets for final position calculation.
- Concentrator Server uses Timestamps for error correction

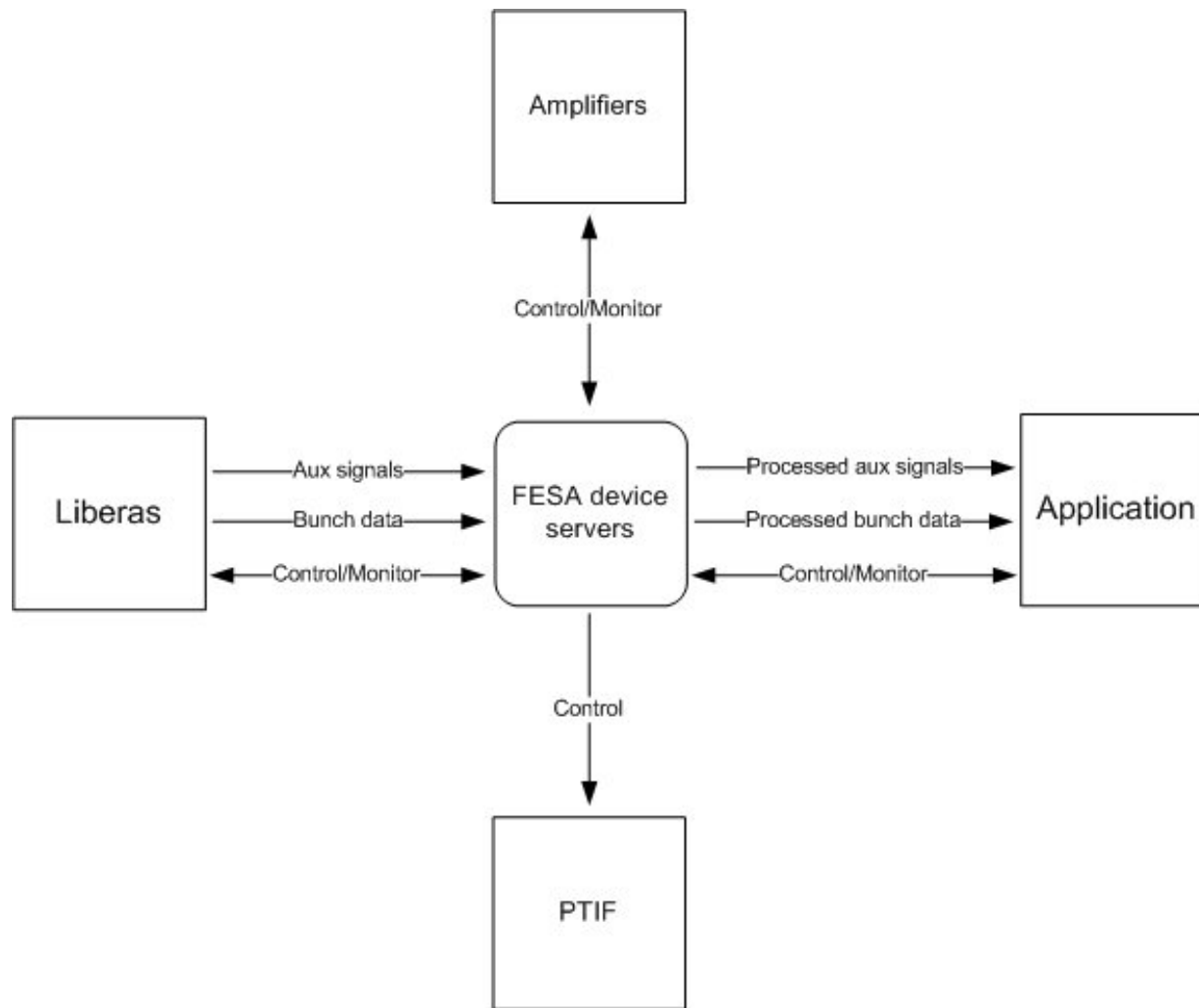


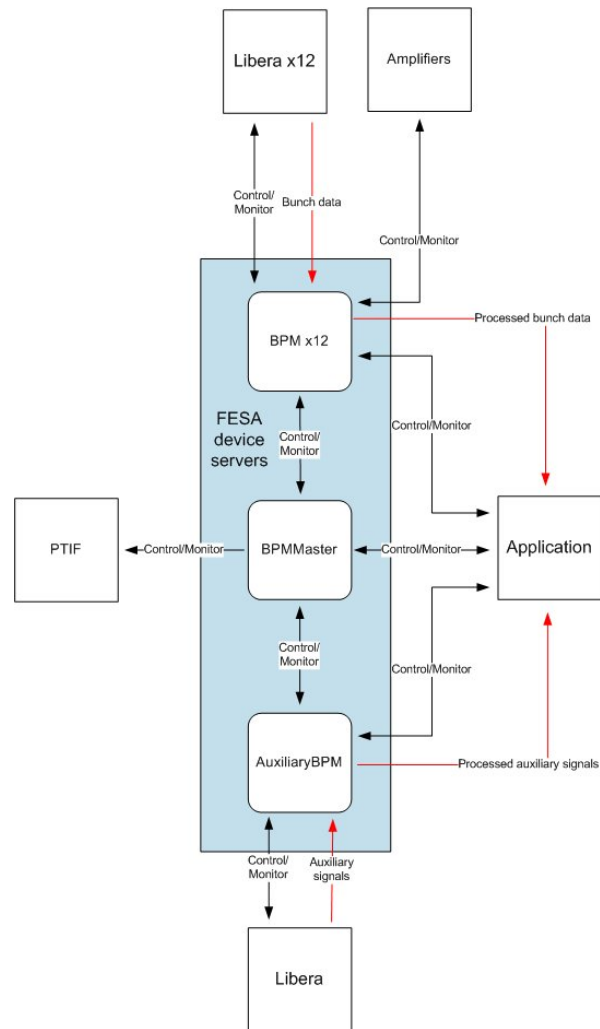
BPM GUI





Ende





Timestamps

